ARTICLE

BIOLOGICAL, SOCIAL, AND COMMUNITY INFLUENCES ON THIRD-GRADE READING LEVELS OF MINORITY HEAD START CHILDREN: A MULTILEVEL APPROACH

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The purpose of the study was to determine the impact of individual and community level risks on school outcomes of children who attend Head Start. We studied a sample of 3,693 African American and Hispanic children who had been born in New York City, participated in Head Start, and attended New York City public schools. The outcome was the

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score obtained on a citywide third-grade reading test. Individual level risk factors were derived from birth certificate data. Community level risks were extracted from citywide U.S. Census data and other public-access data sets. Multilevel regression analyses indicated that at the individual level, lower reading scores were significantly associated with: male gender, low birth weight, unmarried mother, low maternal education, and inadequate interpregnancy spacing. Controlling for individual-level risk, concentrated community poverty significantly lowered reading scores, and a high percentage of immigrants in the community significantly raised scores. There was also a significant crosslevel effect: boys benefited more than girls from the immigrant community effect. The evidence suggests that we can better identify children at future educational risk and maximize the success of early intervention programs by exploring influences on school success at multiple levels, including the community.

Many American children live their lives burdened by biologic and social conditions that severely limit their potential for successful school experiences. The New York City Board of Education identifies approximately 12% of children as needing some type of special education services (Berger, 1991). Furthermore, there are communities in New York City in which 68–74% of elementary school children are reading below grade level, compared with 46% city-wide (Citizens' Committee for Children of New York, 1997).

There is an extensive literature documenting the impact of individual biologic and socioeconomic risk factors on child development and school performance, and a growing literature on the developmental effects of urban neighborhood conditions (e.g., Brooks-Gunn, Duncan, & Aber, 1997) At the individual level, the impact of biomedical and psychosocial influences on intellectual development appears to be cumulative (Dunst & Trivette, 1994; Sameroff, Seifer, Barocas, Zax, & Greenspan, 1987), accounting for a significant proportion of the variance in school outcomes (e.g., Goldberg, McLaughlin, Grossi, Tytun, & Blum, 1992). Garbarino estimates that as many as 20% of American children experience a major accumulation of risk, including poverty, single-parent households, low parental education, and other social disadvantages (2001). At the neighborhood level, social and economic conditions have been shown to account for only 2–5% of the explained variation in child educational outcomes, after adjustment for individual risk (e.g., Klebanov, Brooks-Gunn, Gordon, & Chase-Lansdale, 1997), suggesting that there is greater variability among families within neighborhoods than between neighborhoods. Cognitive and achievement measures appear to be somewhat more sensitive to neighborhood influences than behavioral measures, and these effects become more apparent as children enter the school years. As reviewed below, the presence of significant and relatively enduring effects of both individual and community characteristics on elementary school achievement argues for the inclusion of such measures in epidemiological studies of child performance, including evaluation of early intervention program effects.

BIOLOGIC AND SOCIAL VULNERABILITY

School performance has been related to a range of biomedical and behavioral risks at the time of birth, including birth weight and gestational age (Lagerstrom, Bremme, Eneroth, & Janson, 1991; Resnick, 1991), birth complications (Kramer, Allen, & Gergen, 1995), and antenatal exposure to high-risk health behaviors, such as smoking, alcohol, and drugs (Drews, Murphy, Yeargin-Allsopp, & Decoufle, 1996; Fergusson & Lloyd, 1991; Olds, 1997). An important group of biologically vulnerable children includes those born at low birth weight (<2,500 grams)—a reliable population-based indicator of subsequent child health and development. These children, particularly those with very low birth weights (<1,500 grams), have been shown to be at higher than average risk for poor intellectual performance (e.g., Escalona, 1982; Jonas, Chan, Macharper, & Roder, 1990; McCormick, Gortmaker, & Sobol, 1990). Specific school-related sequelae have been documented by Hack et al. (1994), especially among children whose birth weights were less than 750 grams, 45% of whom required special education in school. In a case–control study of New York City birth certificates linked to third-grade school outcomes, Goldberg, McLaughlin, Grossi, Tytun, and Blum identified three risk factors that make significant independent contributions to the prediction of use of special education services: male gender, Medicaid coverage at the time of birth, and one or more medical complications of birth (Andrews, Goldberg, Wellen, Pittman, & Struening, 1995; Goldberg et al., 1992).

Not surprisingly, children who start life with one or more biologic risks are also more likely to be low income, thus experiencing the added burden of social risks associated with economic disadvantage. Specifically, studies have shown that the rate of low birth weight increases as median family income decreases across race/ethnic groups (Collins & David, 1990; McCormick et al., 1990; O'Regan & Wiseman, 1989; Williams, Binkin, & Clingman, 1986). The early work of Ramey and his colleagues provided evidence that the effects of biologic and social risks obtained from birth certificates (such as race, sex, birth order, birth weight, length of gestation, etc.) were far-reaching, predicting first-grade school performance (Ramey, Stedman, Borders-Patterson, & Mengel, 1978). The impact of these perinatal conditions, however, decreases with age, as intervening environmental effects contribute increasingly to school outcomes (Chamberlin, 1987). Other early studies by Escalona (1982) and Palfrey, Singer, Walker, and Butler (1987) further demonstrated that biologic risks could be modified by social circumstances, and that socially disadvantaged children with biologic risks were at double jeopardy for impaired developmental progress and learning disorders in childhood. More recently, Duncan and colleagues reviewed the influence of economic deprivation on early childhood development, using data from the Infant Health and Development Program and the Panel Study of Income Dynamics (Duncan, Brooks-Gunn, & Klebanov, 1994). They found that, among the measures available in these data sets, family income was the most powerful correlate of intellectual development at age 5 years, and that persistent poverty had effects roughly twice that of transient poverty.

In addition to biologic and economic factors, maternal race, education, place of nativity, and immigrant generational status have been shown to have meaningful effects on child educational outcomes. Quality of the home environment is another condition that has been linked with literacy and reading development in the early and middle school years (e.g., Lee & Croninger, 1994; Parker, Boak, Griffin, Ripple, & Peay, 1999). The children of first-generation immigrants have better birth outcomes

(Cabral, Fried, Levenson, Amaro, & Zuckerman, 1990; David & Collins, 1997; Williams, Binkin, & Clingman, 1986) and fewer health-related school absences in adolescence (Hernandez & Chrmey, 1998). The individual social, economic, material, and cultural factors responsible for providing this protection are largely unexplored, nor do we understand why increased exposure and acculturation to mainstream urban life is so often accompanied by worsening health and developmental outcomes (e.g., Zambrana, Schrimshaw, Collins, & Dunkel-Schetter, 1997). Recently, the National Research Council and the Institute of Medicine called for increased funding for longitudinal studies on health and development of immigrant and native-born ethnic groups to identify factors influencing child health and development (Hernandez & Chrmey, 1998).

COMMUNITY EFFECTS ON CHILD ACADEMIC DEVELOPMENT

Ecological theory, with its rich tradition in the field of child development (i.e., Bronfenbrenner, 1979, 1989), strongly suggests that influences on a child's development are ongoing and that the multiple contexts in which he or she resides are important. A growing literature provides empirical evidence that geographic concentration of poverty results in environments that place children at risk for health and developmental problems. Coulton and Pandey (1992) found that highly concentrated poverty was negatively associated with school reading performance, as measured by the average score on standardized reading tests for third grade public school students. Brooks-Gunn, Duncan, Klebanov, and Sealand (1993) reported that the presence of affluent neighbors was associated with higher intelligence test scores at 3 years of age, after controlling for family income, family structure, maternal education, age, and ethnicity. Similar findings with respect to the verbal ability scores of 5 and 6 year olds were reported by Chase-Lansdale and Gordon (1996). More recent work by Duncan and Raudenbush (1999) suggests that school and neighborhood settings are the most important extrafamilial contexts for school-age children. Because individual income determines (or limits) neighborhood of residence to a large degree, the association between individual poverty and child developmental and behavioral outcomes may be at least partly determined by the adverse effects of other stressful exposures that are associated with community poverty (e.g., Leventhal & Brooks-Gunn, 2000).

Despite the importance of economic conditions for children's development, not all low-income communities are alike, belying the uniform picture of poverty. Communities vary on key dimensions of quality and risk, and some of these additional indicators exert powerful influences on the outcomes of children and families who reside therein. For example, communities may be comparable in terms of median income, yet enjoy tremendous diversity with respect to social cohesion, availability of resources, and proportion of immigrants—all with potentially powerful impact on child outcomes (e.g., Garbarino and Kostelny, 1992; Manfredi, Lacey, Warnecke, & Buis, 1992; Reeb, Graham, Zyzanski, & Kitson, 1987; Sampson, Raudenbush, & Earls, 1997). Immigrant neighborhoods in particular are not uniformly impoverished, varying on dimensions such as concentrated poverty, ethnic diversity, and social cohesion, with meaningful effects on children's school adjustment (Spencer, 1999). Polednak and others have shown that the degree of residential segregation, measured at the aggregate level, is a stronger predictor of child health and development than individual race, suggesting that social conditions may moderate the impact of individual risk (Polednak, 1997; Wise, 1993).

The notion that community conditions may *override* or *moderate* the impact of individual risks on child development is compelling. Researchers have demonstrated that exposure to stressful life conditions can increase susceptibility to behavioral and developmental deficits in the young child (Cowen, Wyman, & Work, 1996; Florsheim, Tolan, & Gorman-Smith, 1996; Garbarino, 2001; Leadbeater & Bishop, 1994). Similarly, exposure to a positive environment has been shown to foster resilience in children otherwise at risk for behavioral and developmental problems (Garmezy, 1993; Garmezy, Masten, & Tellegen, 1984; Garmezy & Rutter, 1983; Losel & Bliesener, 1990). The ways in which individual and community-level conditions interact to affect child outcomes are poorly understood, but it is clear that exposure to highly stressful and threatening environments among children with a high accumulation of individual risk and few resources is likely to result in school failure for the overwhelming majority of children in such neighborhoods (Tolan & Henry, 1996).

HEAD START: MULTIPLE INFLUENCES ON LONG-TERM SUCCESS

Head Start, funded by the Department of Health and Human Services (DHHS), is the largest federally funded program for economically disadvantaged preschool children in this country. Head Start grew out of a belief in early education as the solution to poverty, and the preschool years as a critical period. To prevent school failure, the program was designed to begin before school entry—to get children off to a better start and to assist in the transition to the school environment. As one of the nation's great social experiments, Head Start remains unrivaled, but continues to pose tremendous challenges for those who seek to evaluate its effects. Because children are not randomly selected into Head Start and the programs themselves are not randomly assigned to communities, a method of evaluation is needed that can measure the potential impact of ongoing community-level conditions, while adjusting for individual differences in biologic and social characteristics. Such approaches are lacking in Head Start research and the early intervention field in general (Powell, 2001). The ability to assess community influences is critical, because the measured efficacy of Head Start and Head Start-like programs may well depend at least as much on what happens to a child outside of the program or after the program ends, as the carefully documented components of the intervention itself. The ability of Head Start to make a difference or change the trajectory of development for children with early biologic or social risk may be powerfully affected by the quality of the neighborhoods and schools children are exposed to before, during, and after the early intervention experience.

The diversity of the communities—largely low-income—in which Head Start centers are located is part of the fabric of the Head Start system, yet has never been adequately addressed in studies that assess the outcomes of Head Start children. The selection of program sites is guided by a structured community-needs assessment that operationalizes "need" in terms of the percentage of preschool children in public assistance households and other poverty-related data. Just as communities may influence individual need, communities may facilitate or hinder a program's capacity to meet performance targets, some portion of which may be influenced by conditions beyond the control of the program.

If factors influencing a child's school success reside in the community as well as the child, both factors should be included in models predicting educational outcomes. This poses analytic problems because the individual and community factors are not independent; that is, families are not randomly assigned to communities (just as children are not randomly assigned to Head Start). Their individual characteristics contribute to where they live, so that families with higher incomes may choose a higher quality community, or immigrant families may choose to live in a community where people speak their native language. Similarly, families may be excluded from certain neighborhoods on the basis of racial discrimination or lack of economic resources. With very few exceptions, most observational studies have applied ordinary regression techniques to the analysis of neighborhood and community effects, including both individual-level and aggregate-level predictors in the models. Bryk and Raudenbush (1988) were among the first to apply multilevel analytic techniques to the educational literature to adjust for the natural nesting of schools within districts, classrooms within schools, and children within classrooms. They found that higher level "contextual" factors were just as important determinants of an individual child's outcome as his IQ, or the skill of the teacher. O'Campo, Yue, Wang, and O'Brien Caughy (1997) used multilevel analysis to assess the effects of individual biologic and social factors, as well as community-level conditions on school outcomes, using a sample from the National Longitudinal Survey of Youth.

Multilevel analysis makes the estimation of individual effects more accurate by taking into account the dependence among individual outcomes within the same neighborhood or other natural grouping (see Bryk & Raudenbush, 1992). Hierarchical models address the problem of nonindependence by incorporating into the statistical model a unique random effect for each neighborhood or other designated macrolevel grouping. The variability in these random effects is taken into account in estimating standard errors. By failing to consider such variability, single-level models may result in incorrectly estimated effects. Multilevel analysis also permits the exploration of conditions under which the association between individual characteristics and educational outcomes vary across neighborhoods or communities. These types of models have been used to account for community- and individual-level effects on child mortality, use of health services, and specific health outcomes in a range of populations (e.g., Bosma, van den Mheen, Borsboom, Mackenbach, 2001; Desai & Alva, 1998; O'Campo et al., 1997).

The present study was undertaken to explore the impact of neighborhood conditions on third-grade reading scores in a cohort of New York City children who participated in Head Start. To accomplish this, Columbia University formed a partnership with the New York City Administration for Children's Services/Head Start to conduct a study of school outcomes of Head Start children. The purpose was to identify social conditions in the community that influence the longer term school performance of Head Start children, while also taking into consideration the impact of individual biomedical risk factors identified at the time of birth.

Specifically, we aimed to: (1) quantify the contribution of medical factors and family characteristics present at the time of birth to the third-grade reading performance of Head Start children; (2) assess the independent impact of community conditions on early reading performance of Head Start children, above and beyond the effects of individual medical and family characteristics; and (3) explore possible moderating effects of community conditions on the predictive power of individual biomedical factors.

METHODS

Study Design and Population

This study used a retrospective cohort design to measure the effects of several community conditions on third-grade reading levels in minority children, while controlling for individual biologic and social-risk factors. The population from which the study sample was selected consisted of: all children born in New York City (NYC) between 1988 and 1992 who were enrolled in Head Start between the years 1991 and 1994, were enrolled in the third grade in a New York City public school, between 1996 and 2000, and completed a third-grade standardized city-wide reading exam during the Spring of 1996, 1997, 1998, 1999, or 2000. The test used by the NYC Board of Education at the time was the McGraw-Hill CTB, a proprietary standardized test of reading ability prepared for the NYC Board of Education by McGraw-Hill. The following is a description of how the research sample of 3,693 was selected from this population.

Because Head Start does not maintain either national or local registries of enrolled children, the only mechanism for identifying Head Start enrollees retrospectively for outcomes research is to review records maintained by individual Head Start centers. Within the framework of a NYC Head Start-Columbia University Partnership, we obtained the cooperation of 67 NYC Head Start centers. Through visits to the centers by project staff, we abstracted identifying information for 12,839 children who had participated in Head Start between 1991 and 1994. The resulting data file, containing the full name, birth date, and gender of each of these children, was sent to the New York City Board of Education (BOE) to be matched against the Biofile, which contains information on all children who have attended NYC public schools. To be considered a match, a Head Start record and a Biofile record were required to be identical with respect to the first six characters of both the first and last name, the month, day, and year of birth, and gender. Of the 12,839 identified Head Start children, a match to the Biofile was obtained for 6,707 (52.2%). The 6,132 nonmatches were children who either: (1) moved out of NYC before third grade, (2) attended a private or religious school, or (3) attended public school but did not have identical name and/or birth date information in our Head Start registry and the Biofile. Of the 6,707 Head Start children for whom Biofile data were available, a subsequent match indicated that NYC birth certificate data were available for 4,779 (71.3%).

To determine whether bias might have been introduced by the matching process, we compared children for whom birth certificate data were available (N = 4,779)—who were retained for subsequent analysis—with those for whom birth certificate data were not available (N = 1,928), with respect to selected public school data elements. There were no significant differences between the groups with respect to special education placement (p = .11) or the percentages achieving state-defined math and reading levels in 1999 (p = .58 and p = .42, respectively). However, the percentage entitled to bilingual services was significantly higher (p < .00001) among those with no birth certificate data (17.9%) than among those with birth certificate data (14.4%), and the percentage of Hispanic students was significantly higher (p < .01) among those without birth certificate data (49.4%) than among those with such data (45.3%). These findings are expected since Hispanic students who receive bilingual services are less likely to have been born in New York City, and therefore more likely not to have NYC birth certificates.

The 4,779 Head Start children who were born in NYC and attended public school in NYC represented 67 Head Start centers in all five boroughs: 1,689 from Brooklyn, 940 from the Bronx, 1,118 from Manhattan, 816 from Queens, and 216 from Staten Island (the least populous borough). Of these 4,779, a total of 503 had left the NYC school system before third grade and, therefore, did not have third-grade reading scores. An additional 281 had standardized reading scores from a different test (not the McGraw-Hill CTB) or a different school year; 302 children were excluded because they were not African American or Hispanic, the predominant minority populations on which this study was focused. Thus, the final research sample consisted of 3,693 African American and Hispanic children born in NYC, who attended public school in NYC through at least third grade, and for whom comparable reading scores were available.

Specification of Variables

The outcome variable for the modeling process was the child's score on the CTB, a third-grade city-wide standardized reading test, adapted by McGraw-Hill from the Terra Nova test series specifically for the New York City Board of Education. Because the scale of the CTB changed between 1996 and 1998, scores for each year were converted to T scores ($M = 50$, $SD = 10$), based on city-wide means and standard deviations available from the NYC Board of Education (see web page; http://nycenet.edu/).

We derived 12 dichotomous indicators of possible biomedical and demographic risk for poor school performance, using NYC birth certificate data, as suggested by previous studies of school performance in NYC (Andrews, Kerner, Zauber, Mandelblatt, Pittman, & Struening, 1995; Goldberg et al., 1992): low birth weight (<2,500 grams), inadequate spacing between births (<18 months between pregnancies), maternal substance abuse (including alcohol), maternal smoking in pregnancy, payment for birth by Medicaid (a poverty indicator), maternal education (<12 years), parity (>2 siblings), lack of prenatal care (no prenatal visits), low 5-minute Apgar score (<8), birth complications (one or more vs. no complications), marital status (unmarried at time of birth), mother's place of nativity (foreign versus U.S. born). All risk factors were coded 1 or 0, with 1 representing the risk conditions. In all analytic models, when a risk dichotomy proved nonsignificant for a continuous variable in which there were no biologically relevant cut point (e.g., Apgar score, number of complications), the analyses were rerun with other cut points, and as a continuous variable, to ensure that the lack of significance was not due to the use of an arbitrary cut point or failure to capture the variability contained in the continuous measure.

At the community level, we derived a set of 44 indicators from U.S. census data and city-wide NYC birth- and death-certificate data to characterize the neighborhoods in which children resided both at the time of birth and during early childhood. These included median income, percentage of residents below the poverty level, unemployment rate, housing vacancy rate, ethnic composition, proportion female-headed household, population stability (in- and out-migration rates), rate of violent crime, teen birth rate, neonatal and postneonatal death rates. The unit of analysis was the NYC Health Area, as defined by the NYC Health Department. On average, each Health Area contains approximately 20,000 people and is an aggregate of four to six contiguous U.S. census tracts.

The selected indicators were derived from data available from INFOSHARE software (Community Studies of New York, Inc.); the selection of relevant indicators was guided by the Head Start Partnership team (Parker, Piotrkowski, & Peay, 1995) and by previous community-level research (Andrews et al., 1994; Kerner, Andrews, Kerner, Zauber, & Burnett, 1991; Kerner, Struening, Pittman, Andrews, Sampson, & Strickman, 1984; Streuning, Wallace, & Moore, 1990). Because of the high degree of intercorrelation among many of the 44 community indicators, we performed a factor analysis to identify the dominant dimensions of NYC communities, to determine the specific indicators associated with these dimensions, and to select a small number of salient community indicators for use in the modeling process. The analysis revealed two strong factors characterizing NYC communities: (a) income—poverty and associated social and health conditions, and (b) a factor reflecting foreign-born population (e.g., % immigrants, % persons living in the United States for less than 5 years). Based on these results, we selected a single indicator to represent each of these dominant factors in our modeling process: (a) concentrated poverty (a dichotomy, 1 = more than 40% of families in the community living below the federally defined poverty level; 0 = 40% or less of families in the community below poverty level); and (b) % foreign-born population.

Data Analysis

The first stage of analysis was conducted using all 12 of the individual-level biomedical and social-risk factors described above. This process resulted in a reduced model in which we included only risks that made a significant contribution to the prediction of reading scores, controlling for the effects of all other variables in the model. The second stage of analysis involved the multilevel modeling of community and individual risks on reading scores. Note that each community-level variable (concentrated poverty and % foreign born) had an individual-level counterpart: individual poverty (Medicaid payment for birth) and mother's nativity. Because it was important to determine whether community-level effects had an impact on reading scores when individual-level factors were controlled, individual foreign-born status was retained in the modeling process even though it was not a significant predictor at the individual level.

We tested multilevel models using SAS PROC MIXED to estimate the contribution of individual and community characteristics to reading scores. A final multivariate model was computed for each of the two community indicators (poverty and % foreign born), including the main effects and tests of interaction of each biomedical variable with the community indicator. This strategy was adopted to maintain large cell sizes in the estimation of community effects on both slope and intercept. We did not center % foreign born, which was the only continuous variable. Nonsignificant variables were dropped from the model in a backward stepwise procedure, beginning with the interaction terms. The models were tested with random intercept and fixed slopes, so that each community regression line was permitted to vary on intercept, but not slope. In the fixed effect portion of the model, we tested the significance of the selected individual and community characteristics. The reader should refer to Bryk and Raudenbush (1992) for further details on this method.

The random intercept permitted the relationship between the community variable and reading scores to vary for each community. Fixed-effects estimates are equivalent to linear regression with the nonindependence of individuals within a health area taken into account. These models thus provide an indication of the maximum variation in outcome that can be explained by observed community characteristics (e.g., concentrated poverty), as well as observed characteristics of the children who live within the same community.

RESULTS

Demographic and Biomedical Characteristics of the Matched Sample

Table 1 describes the characteristics of the 3,693 minority children who were born in NYC between 1988 and 1990, participated in NYC Head Start, attended third grade in the NYC public school system, and had CTB scores for the third grade. The sample comprised children of African American (52%) and Hispanic (48%) mothers, a large proportion of whom were unmarried (66.5%), and poor, as indicated by Medicaid payment for the birth (63.9%); the average age of the mothers at the time of the child's birth was 25. Nearly 11% of the children in the sample were born at low weight (<2,500 grams) and 1.2% were very low birth weight (<1,500 grams). Nearly two-thirds

Table 1. Description of the Head Start Sample

*Individual level (*N *= 3,693)*	*Mean*	*(SD)*
Maternal age	25.25	6.01
Maternal education (years)	11.21	2.02
Parity	2.61	1.94
Number of prenatal visits	8.37	4.36
5-minute Apgar	9.18	0.76
Birth complications (number)	0.34	0.59
Birth weight (grams)	3196.00	593.00
Number with individual risk factors:	Number	(%)
Inadequate spacing	246	(6.7)
Low birthweight (< 2500 gms)	395	(10.7)
Very low birthweight (< 1500 gms)	45	(1.2)
Moderately low birthweight (1500–2500 gms)	350	(9.6)
African American	1919	(52.0)
Male	1789	(48.4)
Maternal substance abuse	175	(4.7)
Medicaid	2358	(63.9)
Unmarried	2455	(66.5)
Smoking	325	(8.8)
Mother born in the United States	1171	(31.7)
Any birth complications	1016	(27.5)
No prenatal care	459	(12.4)
5-minute Apgar less than 8	79	(2.1)
More than two siblings	2288	(62.0)
Less than 12 years of education	1643	(44.5)
Community level: $N = 51$ health areas		
Concentrated poverty:		
Percentage of families below poverty level	29.8	13.8
Percentage foreign born (percent)	21.9	13.5

of the Head Start children were born into families with two or more siblings, and an absence of prenatal care was reported for 12.4%.

Modeling of Individual Risk

We assessed the contribution of each biomedical and social risk to the child's reading score, while simultaneously adjusting for the effects of all other variables. Table 2 shows that birth characteristics accounted for a significant portion of the variability in third-grade reading scores, such that for each individual risk factor, there was a significant drop in reading percentile as follows: male (2.6 points), unmarried mother (1.8 points), less than high school education (1.9 points), and inadequate interpregnancy spacing (2.3 points). The intercept estimate of effect in the model including only significant independent variable (53.137) is the estimated average health-area reading t-score, adjusted for all the other variables in the equation. Note that neither of the individual level counterparts of the community-level factors selected for inclusion in multilevel modeling, individual-level poverty (mother's Medicaid status) and mother's nativity, were significant predictors of reading score. Moreover, there was no significant effect of race. Low birth weight was marginally significant ($p = .053$), and was therefore included in subsequent multilevel modeling.

Multilevel Modeling

The distribution of community-level risk among all NYC communities is shown in maps for concentrated poverty (Fig. 1) and % foreign-born population (Fig. 2). The

Table 2. Multilevel Regression Results: Individual-Level Variables

Variable	*Estimate of Effect*	*Standard Error*	t-*Value*	*Degrees of Freedom*	p-*Value*
Intercept	53.339	0.533	100.15	50	<.0001
Male child	−2.639	0.329	−8.02	3418	<.0001
Medicaid	0.0085	0.360	0.02	3418	NS
Low birth weight	−1.049	0.541	−1.94	3418	0.053
Unmarried	−1.826	0.382	−4.78	3418	<.0001
Black	−0.578	0.400	−1.44	3418	NS
Delivery complications	0.684	0.373	1.83	3418	NS
No prenatal care	−0.213	0.500	−0.43	3418	NS
Substance abuse	−0.298	0.788	−0.38	3418	NS
Apgar score less than 8	−0.008	1.147	−0.01	3418	NS
Mother born in United States	−0.353	0.380	−0.93	3418	NS
Less than HS education	−1.870	0.340	−5.50	3418	<.0001
Inadequate spacing	−2.271	0.665	−3.42	3418	.0006
More than two siblings	−0.044	0.346	−0.13	3418	NS
Significant individual-level variables only					
Intercept	53.137	0.412	128.82	50	<.0001
Male child	−2.637	0.328	−8.03	3426	<.0001
Low birth weight	−1.055	0.528	−2.00	3426	0.0457
Unmarried	−1.982	0.362	−5.49	3426	<.0001
Less than HS education	−1.857	0.336	−5.54	3426	<.0001
Inadequate spacing	−2.340	0.655	−3.57	3426	.0004

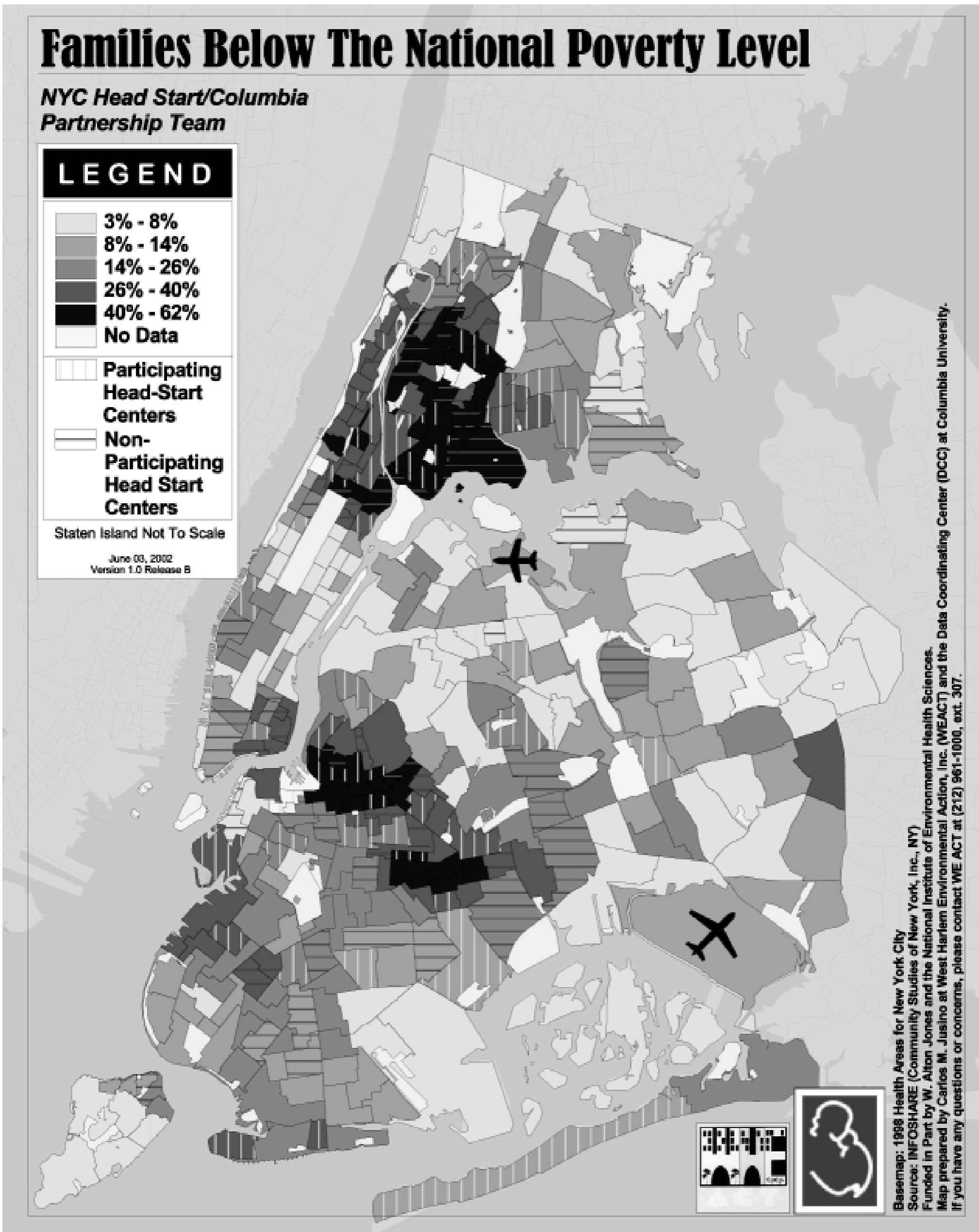

Figure 1. Percentage of families below poverty level in New York City communities. The geographic unit is the Health Area, average population approximately 20,000.

maps indicate communities in which there was a participating Head Start program (N = 51), and those in which there were nonparticipating programs (N = 64). As shown in Figure 1, Head Start communities were, as expected, poorer than communities without Head Start programs. However, there was substantial variability in level

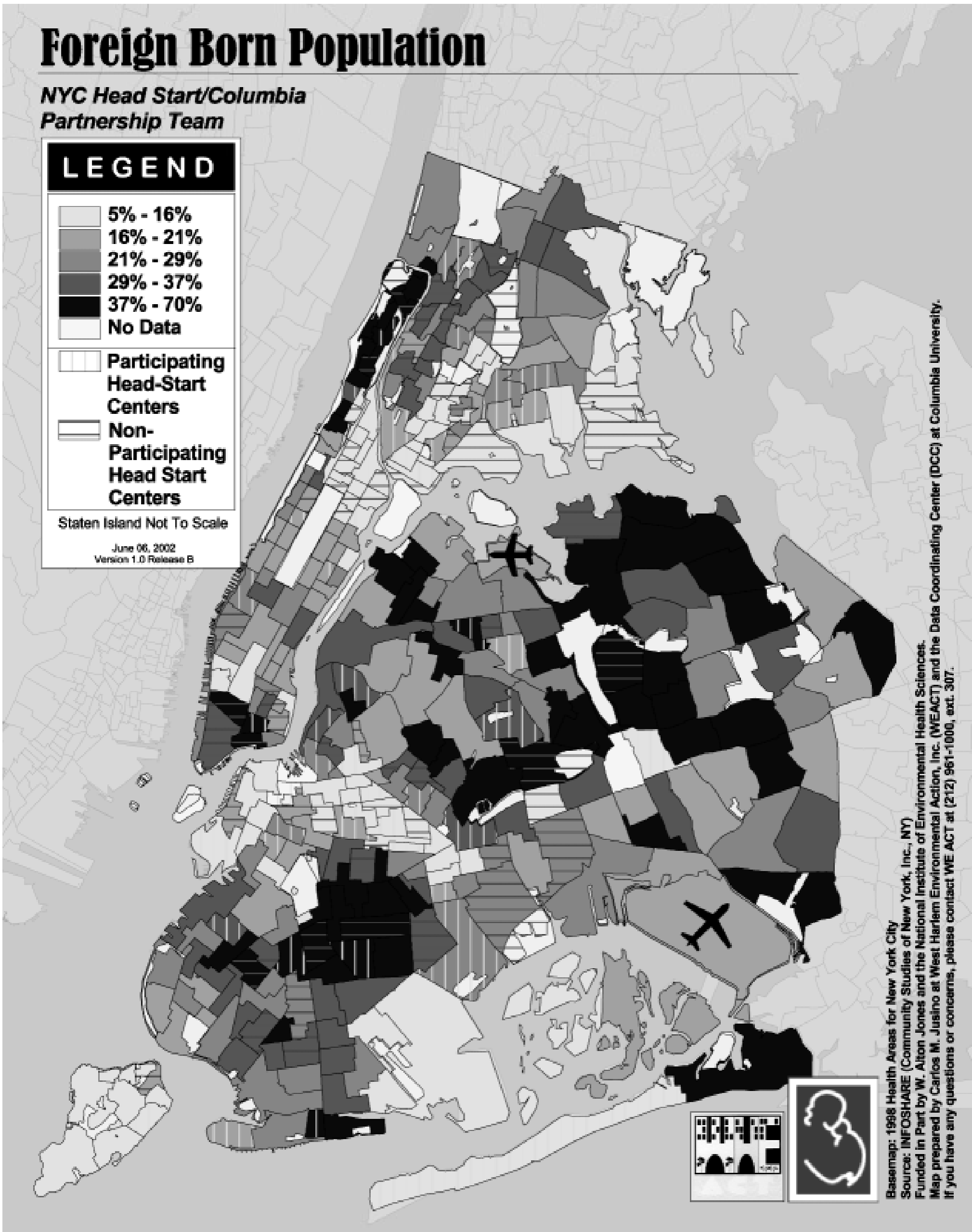

Figure 2. Percentage of people in New York City communities who were born outside the United States.

of poverty within Head Start communities, and only 12 of the 51 participating Head Start communities reached the criterion for concentrated poverty (>40% of families below poverty level). Comparing Figure 2 with Figure 1, it is clear that the second community factor, % foreign born, is not strongly related to poverty—immigrant communities varied greatly in terms of income level, and just as with community poverty, there was substantial variability in the % foreign-born population within Head Start communities.

To determine whether communities in which participating Head Start centers differed from communities of nonparticipating centers, we used independent-samples *t*-tests to compare the means of all 44 community indicators (see Methods) in participating and nonparticipating communities. None of these tests were significant, and mean values of all variables were quite similar in the two area types, indicating that the communities of participating Head Starts were representative of all Head Start communities.

A PROC MIXED model to test the effect of each community-level indicator, adjusting for the effects of individual risks, is shown in Table 3. Only individual-level variables that were significant in the initial model (Table 2) were used in this model. The exception was Medicaid status; we included this variable because it is the individual-level counterpart of community poverty, and we wanted to control for individual poverty while testing for a community effect. The results indicate a significant effect of community poverty when individual-level predictors were controlled: in areas of concentrated poverty, the average reading score is reduced by 1.6 points when all individual-level variables are controlled. There were no significant interaction terms in the model, indicating that the impact of individual-risk factors did not differ as a function of community poverty.

Table 4 shows the impact of the second community indicator, percentage foreign born. There is a significant positive effect of the community indicator, over and above the contribution of individual-risk variables, such that reading scores increase with percentage foreign born living in the community. In this model, there is also a significant interaction such that a male living in a community with a high percentage of foreign born individuals had a higher reading score compared to a male residing in a community with a lower percentage foreign born, with all other individual level variables controlled. As with the poverty effect, we retained the individual-level counterpart of the community effect, mother's nativity, even though it was not significant in the individual level model. The results confirmed that both the main community effect—and the additional gender-specific advantage for males living in immigrant communities—are independent of the mother's individual-level immigrant status.

Table 3. Multilevel Regression Results: Concentrated Poverty

	Estimate of Effect	*Standard Error*	t-*Value*	*Degrees of Freedom*	p-*Value*
Individual level					
Intercept	53.382	0.446	119.66	49	<.0001
Male child	−2.656	0.328	−8.09	3425	<.0001
Low birth weight	−1.033	0.528	−1.96	3425	.0505
Unmarried	−1.966	0.369	−5.32	3425	<.0001
Medicaid	0.078	0.357	0.22	3425	.8278
Less than HS education	−1.830	0.337	−5.43	3425	<.0001
Inadequate spacing	−2.384	0.655	−3.64	3425	.0003
Community level					
Concentrated poverty	−1.630	0.636	−2.56	49	.0135

Table 4. Multilevel Regression Results: % Foreign-Born

	Estimate of Effect	*Standard Error*	t-*Value*	*Degrees of Freedom*	p-*Value*
Individual level					
Intercept	52.486	0.607	86.43	49	<.0001
Male child	−4.2460	0.637	−6.66	3424	<.0001
Low birth weight	−1.017	0.527	−1.93	3424	.0537
Unmarried	−1.858	0.362	−5.13	3424	<.0001
Less than HS education	−1.818	0.334	−5.44	3424	<.0001
Inadequate spacing	−2.401	0.653	−3.67	3424	.0002
Mother born in US	−0.361	0.368	−0.98	3424	.327
Community-level					
Foreign-born	0.034	0.018	1.82	49	.075
Foreign-born × male	0.065	0.022	2.89	3424	.0039

Figures 3 and 4 graphically summarize the individual and community effects that were identified using multilevel analyses. Figure 3 presents mean reading scores for children living in high- versus low-concentrated poverty communities, stratified by individual biomedical and social risk profile. Most striking is the reduction in test scores for children with the greatest number of individual biomedical risks, indicating that the adverse impact of individual risk factors is cumulative. The added risk associated with concentrated community poverty is uniform across the range of individual risk, reflecting the absence of interaction between individual and community risk.

Figure 4 illustrates the crosslevel effect involving individual gender and immigrant communities: the positive effect of immigrant communities, with all individual level

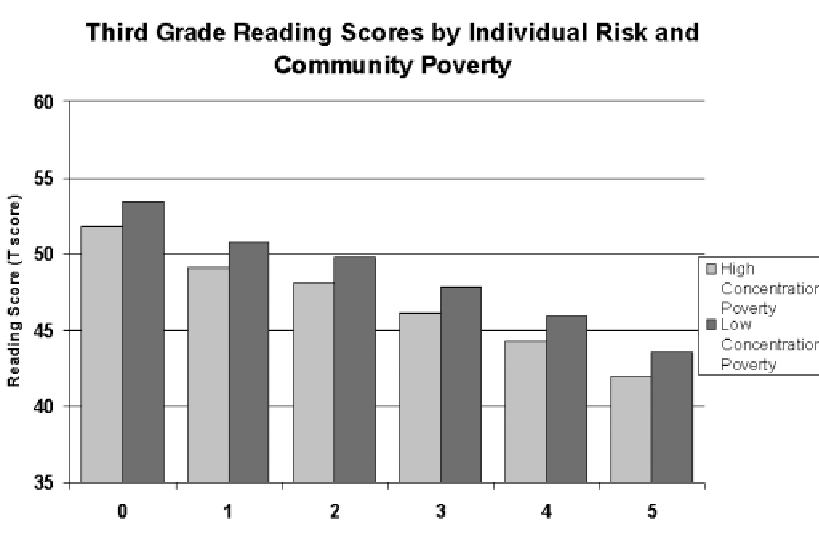

Figure 3. Third grade reading score by level of individual risk and concentrated community poverty. Level zero (0) represents an absence of all significant individual-level risk factors; level five (5) represents the presence of all 5.

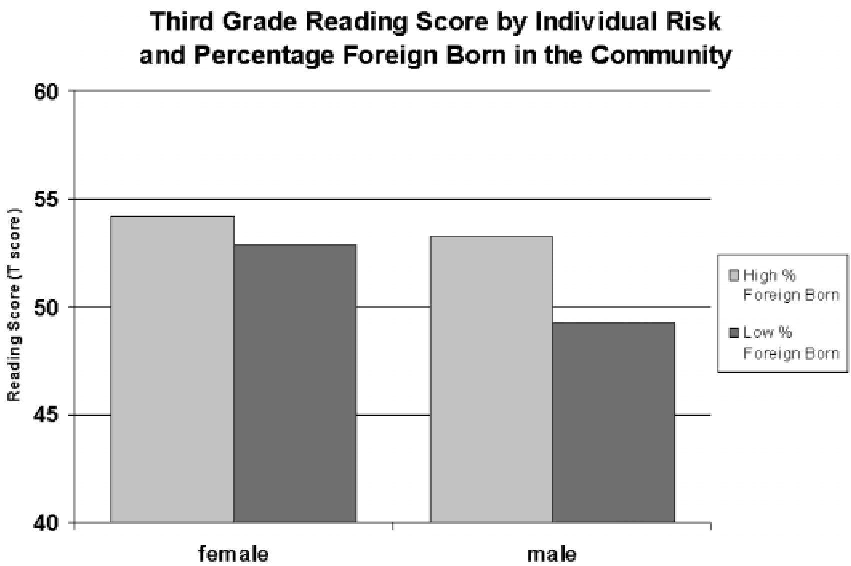

Figure 4. Third-grade reading score by gender and percentage foreign born in the community. Low % foreign born = 10%. High percent foreign born = 51%.

factors controlled, is much greater for boys than for girls. Specifically, while the difference in mean reading score between communities with high and low percentages of foreign-born population is only 1.36 for girls, the differential for boys is 4.06. Thus, the positive effect of residence in high-immigrant communities is nearly three times greater for boys than girls. In fact, it can be seen that boys living in immigrant communities do almost as well as girls living in those communities. Therefore, the beneficial effect of residence in a high-immigrant community for boys nearly offsets the well-known individual-level advantage of female gender with respect to reading scores.

DISCUSSION

Results showed a great deal of variability in level of individual risk among Head Start children. Medical and sociodemographic risks identified at the time of birth were major determinants of third-grade reading performance among NYC public school children who had participated in Head Start. Although not all Head Start children were at high individual risk, those who entered the world with a high number of risk factors continued to bear the consequences into the early school years. This finding is consistent with the results of other studies in clinical populations of children with biomedical disadvantage (e.g., Taylor, Klein, Schatschneider, & Hack, 1998). We also found that community conditions had a significant added impact on reading performance, after taking into consideration the effects of birth factors. Specifically, residence in a community with high concentrated poverty was associated with reduced reading scores, while residence in a community with a high percentage foreign born conferred a protective effect (associated with higher reading scores). Taken together, the findings show that the current environment in which children live does have a significant impact on third-grade school achievement in this population of Head Start children. Furthermore, our findings show that the positive impact of living in a high-immigrant community is substantially greater for boys than for girls, even when we adjust for individual biomedical and social risks.

Sameroff et al. (1987) were among the first to suggest that, beyond the assessment of individual or family factors, an understanding of protective and risk factors in the environment is essential in determining school readiness. In general, the finding of community-level effects is consistent with the notion that processes associated with learning are likely highly context-dependent, and that school and neighborhood settings are the most important extra-familial contexts for school-age children (Duncan & Raudenbush, 1999). Jencks and Mayer (1990) developed a taxonomy of ways in which neighborhoods might affect child development. Of relevance to the present findings is the “Institutional” model in which the neighborhood’s institutions (e.g., schools and other organizational entities) make the difference above and beyond the influence of the neighbors themselves.

However, the interpretation of multilevel effects always raises the possibility that the estimated community-level effects are more a function of the kinds of children who reside in particular neighborhoods than properties of the neighborhoods themselves. In the present study, the neighborhood indicators of poverty and immigrant mix may be proxies for other unmeasured differences among the children who live in the various communities, resulting in a kind of selection artifact. With respect to the immigration effect, this would mean that children who are “selected into” communities with a high proportion of immigrants tend to be those with capacity for better reading performance. By definition, all children in this population were born in NYC (they had NYC birth certificates). By adjusting at the individual level for maternal place of nativity (U.S. versus foreign born), we have controlled for the possible “healthy immigrant” effect that may select robust and talented individuals for migration to the United States. That is, a child of a foreign-born mother had no particular advantage with respect to reading score in the third grade. The significance of the community-immigrant effect, however, suggests that it is advantageous for a child to live in a community with a high proportion of immigrants, regardless of whether or not his/her own mother was foreign born.

Of interest, the communities that were identified as having a high proportion of immigrants were not necessarily ethnically homogeneous. The high-immigrant communities were not those that had the highest proportion of any one ethnic group in NYC, nor were they necessarily the most impoverished communities. This is consistent with Wilson’s observation that immigrant neighborhoods are not homogeneously impoverished, and may be very different from those neighborhoods characterized by the flight of the more affluent residents, leaving a concentration of poverty and immobility (Wilson, 1987). Rather than reflecting low income, the community-immigration variable employed here seems to capture diversity. This phenomenon differs from residential instability (frequent moves), a condition that is often associated with adverse child outcomes (e.g., Sampson et al., 1997). It is perhaps the community-level equivalent of the “healthy immigrant” effect, which has previously been described by epidemiologists as a characteristic of individuals.

Evidence of the presence of a healthy-immigrant community effect comes from both the sociological and the educational literatures. Neighborhoods with a high-immigrant population are unique in their blend of social and cultural processes—all of which might be expected to influence behavior and school performance, both positively and negatively (Spencer, 1999). Children are exposed to sociocultural expectations as part of the social environment of their communities, and these expectations, in turn, influence the development of cognitive abilities, motivation for learning, and school success. Ethnic diversity itself has been reported to be positively associated with educational success (as measured by years of completed schooling) among African American boys (Duncan et al., 1994; Halpern-Felsher et al., 1995). Other studies have found that racial/ethnic diversity is negatively associated with children's school readiness and verbal ability (Chase-Lansdale & Gordon, 1996).

Large-scale investigations of school success, using Current Population Survey Data, have shown that educational attainment tends to peak in the child-of-immigrant generation for Asian and non-Hispanic White groups, and improves with successive generations of U.S. residence for Hispanic populations (e.g., Rong & Grant, 1992). The characteristics of immigrant communities that may underlie some of the observed demographic trends suggests that first- and second-generation ethnic communities frequently enjoy stable and highly adaptive forms of attachment—attachments that are highly functional for the children residing in these communities. However, the same research found that these types of attachments may actually inhibit further progress toward acculturation and success in subsequent generations, as the communities change over time. The future of immigrant communities is variable, and likely depends on political participation and other forms of social capital (Fuchs et al., 2001), conditions that may also affect school performance and attainment of the children residing in these communities. In the present study, those Head Start children who lived in predominantly first-generation immigrant NYC communities appear to have benefited from the diversity and other aspects of the social context, including unmeasured conditions such as family cohesion and community togetherness.

Overall, there is growing evidence of neighborhood effects on school achievement, especially related to the likelihood of school dropout as children move through the school system (e.g., Brooks-Gunn et al., 1993; Connell, Halpern-Felsher, Clifford, Crichlow, & Usinger, 1995; Crane, 1991; Ensminger, Lamkin, & Jacobson, 1996; Entwisle & Astone, 1994). At the same time, the literature continues to support the critical importance of individual characteristics. For example, the diminution of Head Start benefits seems to be greatest for those children who are most cognitively disadvantaged (Lee, Brooks-Gunn, Schnur, & Liaw, 1990)—a result that is consistent with our own findings of continuing impact of early biomedical risk into the early school years. McLoyd (1998) has shown that persistent poverty has even more detrimental effects on school achievement than transitory poverty, possibly through its association with exposure to chronic stressors, and this introduces a temporal element into the assessment of individual and contextual effects (a limitation of the present study). In the current study, community rather than individual-level poverty had a significant impact on school outcome.

Although early research on neighborhood effects focused on whether neighborhood-level variables contribute any explanatory power to child outcomes, over and above that accounted for by individual characteristics, more recent work addresses the question of how individual- and neighborhood-level characteristics might work together to influence individual outcomes (e.g., Duncan & Raudenbush, 1999; Lyman, Caspi, Moffitt, Wikstrom, Leober, & Novak, 2000). A number of studies have reported neighborhood effects on males but not females (e.g., Connell et al., 1995; Crane, 1991; Entwisle & Astone, 1994). Ensminger et al. (1996) suggest that this may be related to the greater community exposure afforded to males, especially in low-income communities where females may be restricted to home or other safe environments. Our own finding that males benefit significantly more than females from the advantages of immigrant communities indicates that poverty is not the only community influence that can have differential effects for boys and girls.

In the present study, we illustrate how individual biomedical and psychosocial characteristics can be examined along with tests of community effects to arrive at a better understanding of which children are most vulnerable to environmental adversity and, conversely, which children are most likely to benefit from positive neighborhood conditions. These results have important implications for the early intervention field. That is, in the evaluation of program effects, it may be a real advantage to be able to assess the contribution of both individual- and community-level factors to program success. For example, intervention may succeed in providing social support (Parker, Piotrkowski, Horn, & Greene, 1995; Parker, Piotrkowski, & Peay, 1987), linking a family to a medical home or preparing a child for school, but community conditions may be so unfavorable (i.e., high unemployment rates, high crime rates) that there is no reduction in the likelihood of an adverse outcome such as child abuse or school dropout. An individual-level evaluation might show no program benefits at one site, whereas a multilevel evaluation might be able to identify the level of community risk at which the benefits of intervention are no longer significant, or who is most likely to benefit from services in a high-risk community.

It has been suggested by Lee et al. (1990) and others that the apparent attenuation of positive Head Start effects over time may reflect differences in quality of subsequent schooling or the home environment. Head Start was designed to "boost" the school readiness of low-income children based on *individual* not *neighborhood* disadvantage. On the other hand, the location of a program site is based on poverty-related criteria in the community, so that programs are only located in relatively low-income communities. Head Start thus serves the least advantaged children in poor neighborhoods, and these children are quite likely to continue to reside in such neighborhoods and to attend local schools in these neighborhoods (e.g., Ogbu, 1985). Despite the poverty-related criteria for Head Start program site eligibility, we know from the NYC data that these communities are actually quite heterogeneous. If it can be shown that the longer term risk of school failure in this population is at least in part a function of where a child lives (reflecting variations in the characteristics of that community) both during and after the Head Start experience, then perhaps we can design more useful policies for program administration and strategies for evaluating program effects.

In conclusion, the results of this work argue for a "heightened sensitivity" of developmental, behavioral, and educational scientists to the importance of contextual influences on development and achievement of innercity children (Slaughter-Defoe, Nakagawa, Takanishi, & Johnson, 1990). As noted by Slaughter-Defoe and Rubin (2001), these contextual influences include racial mix, peer influence, educational expectations, and the quality of the schools themselves, including excellence in teaching as a potential change agent for the entire community. Although the links between individual and community influences on school outcomes deserve further study, the evidence suggests that we can better identify children at future educational risk and perhaps maximize the success of early intervention programs by exploring the many influences on school success at multiple levels of experience.

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